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AUTHOR Rice, Diana C.; Rainsford, Ann D.
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ABSTRACT

Because of the increased influence of the whole language approach at the elementary and middle school levels and the increased emphasis on enriching instruction through reading across the curriculum, one alternative approach to teaching science which has received some attention from science and science education organizations is the use of children's literature, both fiction and non-fiction. The purpose of this study was to determine the role of children's literature, specifically fantasy, realistic fiction, and informational science trade books in the development of children's ideas in science. The initial sample included over 300 children's trade books for grades K-4 used in classes in children's literature. Content analysis techniques were adapted for use in identifying descriptive information to explore the science concepts presented in these samples of children's literature and to identify the presence of common misconceptions which might contribute to the development or perpetuation of such ideas. It was concluded that both correct and incorrect science concepts are communicated both explicitly or implicitly in each of the three categories: science trade books, fantasy, and realistic fiction and common misconceptions or alternate conceptions are found in each of the three categories. Contains 18 references. (JRH)

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Using Children's Trade Books to Teach Science: Boon or Boondoggle?

Diana C. Rice

Ann D. Rainsford

University of South Carolina-Aiken
Aiken, SC 29801

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The increasingly widespread acceptance of more student-centered methods of teaching with their underlying constructivist roots underscores the importance of children's prior knowledge and prior experience in learning. For new information to be linked to this prior knowledge, however, it is assumed that the learner's "prior knowledge is worth linking to" (Duschl, 1990, p. 99). Research in both cognitive science and science education has revealed serious implications for learning if this information is faulty or incorrect. Over the last 20 to 25 years, studies of "children's science" have documented the nature of children's ideas about a wide range of scientific phenomena and concepts (for example, see Osborne and Freyberg, 1985). We understand less perhaps about how these ideas originate and are propagated. When asked recently to assess the current status of science education research in the area of alternate conceptions and to make suggestions for the future, leading researchers in science education recommended research focusing on finding the causes of these ideas rather than their cure (Wandersee, Mintzes and Novak, 1994).

Perhaps because of the increased influence of the whole language approach at the elementary and middle school levels and the increased emphasis on enriching instruction through reading across the curriculum, one alternative approach to teaching science which has received some attention from science and science education organizations is the use of children's literature, both fiction and non-fiction (Mayer, 1995). Proponents give a number of justifications for their use in the science classroom. Some of these are that children's books are more interesting and relevant to children's everyday lives (Casteel and Isom, 1994; Crook and Lehman, 1990; Hammond, 1992; Stiffler, 1992); they complement weak textbooks available for teaching young children (Crook and Lehman, 1990; Stiffler, 1992); they are less intimidating for some students, particularly those with reading problems (Carlile, 1992; Casteel and Isom, 1994; Crook and Lehman, 1990; Stiffler, 1992); they are available in large numbers to complement a variety of science units (Crook and Lehman, 1990);

support the inquiry approach to teaching science (Hammond, 1992). Advocates of using children's fiction in teaching science contend such books facilitate learning, however this point of view has its opponents who insist that this form of literature interferes with science learning (Mayer, 1995). There are over 50,000 children's trade books currently in print and 4,000 new ones are published each year (Lynch-Brown and Tomlinson, 1993). Yet, research in science education says relatively little about the role of children's literature in the teaching and learning of science.

The role of prior knowledge is as well known to specialists in reading and children's literature as it is to science educators. Reading research since the 1960's has focused on Louise Rosenblatt's transactional view of reading (Cooper, 1993; Cox and Zarillo, 1993). According to Rosenblatt, the reader brings to the reading act prior experiences and these interact with the print before her. As a result, a text's meaning will vary from reader to reader.

Most experts in children's literature agree that the most important personal gain reading provides for children is enjoyment and teachers initially read to children for this reason. When children read or are read quality children's literature, they vicariously experience the vivid events depicted in text and illustrations. As more trade books are introduced to the science classroom, they will contribute to the development of children's intuitive concepts. Obviously, science concepts presented in these books are not necessarily accurate and may contribute negatively or positively to subsequent learning. Not only must elementary teachers become more aware of the role trade books play in science learning, they must become more knowledgeable of the science content as well (Mayer, 1995; Sudol and King, 1996).

As recommended in recent reviews of research in science education (Linn, 1987, 1992; Shymansky and Kyle, 1992) the study described in this paper, which is exploratory in nature, combined the expertise of two faculty members, one a science educator and the other a specialist in children's literature and reading. The question

of common interest which guided the research was, What is the role of children's literature, specifically fantasy, realistic fiction and informational science trade books, in the development of children's ideas in science?

An initial sample of over 300 children's trade books for grades K-4 used in classes in children's literature taught by one of the researchers was identified. This source was thought to be appropriate because preservice teachers typically take to the classroom what they have they have been exposed to their preservice education. This sample of books was first reviewed and each categorized by the reading specialist into the following groups and subgroups: 1) science trade books; 2) fantasy including magic and general fantasy (typically w/anthropomorphism); 3) fiction including realistic fiction and historical fiction; 4) traditional folklore; 5) informational; 6) primary level concept books.

To reduce the sample of books to be examined, several of these categories were eliminated for the purposes of this study including tales of magic, historical fiction, folklore, realistic fiction other than those dealing with science concepts, general informational and primary level concept books. Less familiar perhaps are the last three categories: "other" realistic fiction such as stories about children's everyday experiences, about policemen or family trips; general factual information such as descriptions of other cultures or geography; and primary level books about concepts such as parts of speech or numbers. After a cursory examination of several representatives, the researchers concluded that the relatively small number of science concepts presented in books in these categories would not justify detailed examination as a part of this study.

The two researchers reviewed a large number of the remaining books and identified two different groups of books to be examined in the study. This process again reduced the study sample. In addition, the analysis of two separate groups of books provided the basis for cross-validation of study outcomes. The two groups

together included representatives of three categories: science trade books, realistic fiction, and fantasy. One group focused on a specific science concept commonly found in children's books, " the moon" (see Appendix A). This group of ten books included equal numbers of realistic fiction with a science focus and fantasy. Two of the books were Caldecott Award winners and one was the recipient of the Parents' Choice Award.

The second group of 50 books did not have a single common focus but addressed a number of science concepts ranging from life science topics such as insects, flowers or rain forest life forms to physical science topics such as geological processes, clouds or quicksand (see Appendix B). These books were chosen on the basis of their being among those commonly found in elementary classrooms. Thirty of these books were selected because they were authored by several writers known for writing children's books about science such as Ruth Heller, Jerry Pallotta, Eric Carle and Tomi dePaola. The other 22 were randomly selected from the sample. Twenty-eight of the books in this group were categorized as science trade books, those intended to teach science concepts, 19 as fantasy books, the majority involving anthropomorphism, and three as realistic fiction.

Content analysis techniques (Borg and Gall, 1994) were adapted for use in identifying descriptive information to explore the following specific questions: What science concepts are presented in these samples of children's literature? Are the science concepts which are presented correct or incorrect? Do these books contain commonly known examples of misconceptions, also known as "alternate conceptions," or information which might contribute to the development or perpetuation of such ideas?

Working independently, the two researchers read all of the books in a group and identified science concepts found in them, describing these on 3 x 5 cards. Each researcher then categorized the concepts as "correct" or "incorrect". Subsequently,

the two researchers compared and synthesized the results of the individual analyses of the data from the two groups of books. A number of assertions emerging from the data were defined and a sampling of evidence supporting these assertions described. All assertions were supported by examination of both groups of books.

Assertion One: Correct science concepts are presented in each of the three categories: science trade books, as well as fantasy and realistic fiction books.

Realistic fiction: The moon affects the behaviors of animals. *Follow the Moon*, Weeks, 1995.

Fantasy: Gravity holds us to the Earth. *On the Day You Were Born*, Frasier, 1991.

Science trade book: Animals "use" camouflage as a protection mechanism. *How to Hide a Butterfly*, Heller, 1992.

Assertion Two: Incorrect science concepts are found in each of the three categories : science trade books, fantasy, and realistic fiction.

Fantasy: When a child loses a tooth, a new one grows in its place. . . when a unicorn loses its horn, a new one grows in the middle of his forehead. *Many Moons*, Thurber, 1943.

Realistic fiction: "Quicksand is not a special kind of sand. It is plain sand. But when water is forced upward through the sand, the grains are pushed apart. . .the sand is no longer firm and cannot support heavy weight" *The Quicksand Book*, dePaola,1977.

Science trade book: Mushrooms are "plants" that have no flowers. *The Reason for a Flower*, Heller, 1983.

Assertion Three: Both correct and incorrect science concepts are communicated both explicitly or implicitly in each of the three categories: science trade books, fantasy and realistic fiction

Realistic fiction: Humans are destroying the rain forest. (Correct, implicit, from boys musings about whether the rain forest will be present the next time he visits. *Where the Forest Meets the Sea* , Baker,1987.

Realistic fiction: Quicksand is only found in jungles. (Incorrect, implicit, pictures show jungles and characters dressed like Tarzan and Jane. The only reference to where quicksand is found simply refers to its generally being found "along the shores and in the beds of slow rivers. . ." *The Quicksand Book*, dePaola, 1977.

Fantasy: Ladybugs eat aphids. (Correct, explicit) *The Grouchy Ladybug*. Carle, 1977.

Fantasy: Chameleons can turn reddish, brownish, greenish, yellowish and white. (Incorrect, explicit). *The Mixed -up Chameleon* , dePaola, 1989.

Science trade books: Snakes are slimy. (Incorrect, implicit: "Eels are slimy. Eels are long and thin like snakes. If you do not like to hold

snakes, then you probably would not like to hold eels." *The Ocean*, Pallotta, 1986.

Assertion Four: A number of common science themes or topics can be identified in science trade books, fantasy and realistic fiction. Examples include:

Animals: What is an animal? (including examples and classification); parent/offspring relationships, methods of survival for example. vertebrate groups.
Plants: What is a plant? (including examples and classification); parts of a plant; seeds for example.
Astronomical bodies such as moon, sun, stars.
Humans are the dominant species.
Interdependence of all living things including humans
Dinosaurs are animals that lived long ago.
Rain Forests, their importance and their destruction by humans.
Geological processes including weathering, volcanism, earthquakes.

Assertion Five: Common misconceptions or alternate conceptions are found in each of the three categories: science trade books, fantasy, and realistic fiction. Examples include spiders are insects; all insects are "bugs"; there is "magic" in nature; humans are not animals (some specific examples cited above).

It is interesting that many of the topics and themes addressed in children's trade books are those which have predominated research into children's science (for examples, see Osborne and Freyberg, 1985; Wandersee, Mintzes and Novak, 1994).

A closer look at the types of information found in children's trade books may be provided from a more detailed analysis of the group of "moon" books. As indicated previously, two categories of books, fantasy and realistic fiction, were represented in the "moon" books. A number of types of misinformation, both explicit and implicit ,were identified. Many of the examples reflected common "misconceptions". Most of these ideas were obvious to both members of the research team. Some of the more subtle points were evident only to the science educator, as might be expected.

Incorrect ideas were much more common in the fantasy books than the realistic fiction. In the four books in the latter category, only three examples of misconceptions or erroneous information which could lead to misconceptions were identified. One

which involved the use of descriptive language was reflected in the phrase, the moon and stars "hang" in the sky. Another quite clearly conveyed the idea that all events in nature occur for the benefit of humans, more specifically, one child. The most subtle and potentially the most serious error was the description of the half moon being present at both sunrise and sundown on the same day. This impossibility has implications for learning about phases of the moon and other astronomical motions. It was not surprising that this error was not noticed by the reading specialist.

In the fantasy books, misconceptions, both explicitly and implicitly communicated, related to a number of characteristics of the moon. In these six books, 38 items of misinformation specifically in reference to the moon were conveyed: 11 related to the size of the moon; 5 about its composition; 7 related to its distance from the Earth and, closely related, 5 about its constant position in space; 3 involved anthropomorphizing the moon; 2 were about its shape and 5 other miscellaneous points about other characteristics. In addition, several examples of anthropomorphism related to other objects or non-human animals were found. Examples are listed below:

Size: Moon is size of a thumbnail.

Shape: Moon is flat and round like a coin.

Composition: Moon is made of gold (and of course, cheese).

Position: Moon can be brought down to Earth.

Distance from Earth: The moon can be caught in the limbs of trees.

While examination of the 50 books in the second sample revealed a large proportion of "good science," problems were found in this sample as well. At least 49 separate errors, misconceptions or other misleading allusions. Examples included: seeds fly high enough to be burned up by the sun; fireflies dance around the moon; flies' mimicry of bees identified as "camouflage"; crocodiles can walk on two legs; slugs identified as "bugs." In addition, the use of the terms "icky" and "yucky" in titles

perpetuate negative stereotypes about insects and reptiles.

Wandersee, Mintzes, and Novak (1994) report that there is a great deal of evidence indicating that science textbooks and science teachers are a source of children's science. This study was an effort to explore one other possible contributor, children's literature. Results of the study indicate that, in fact, a great deal of science content is being disseminated through children's fantasy, realistic fiction and science trade books. Not all of these science concepts are correct. As a result of the collaborative nature of this study, it also became evident that misconceptions and inaccuracies are not always apparent to those who are "non-science" educators.

For a number of reasons, it is important that teachers understand the role of prior knowledge in learning in science. It has, in fact, been suggested that faulty prior knowledge may actually doom subsequent efforts to build upon these ideas (Duschl, 1990). Others have pointed out that teachers who are unaware of children's ideas are at a disadvantage in teaching science (Wandersee, Mintzes and Novak, 1994). While reading fantasy books and realistic fiction is a developmentally appropriate experience from the perspective of the "reading educator," the presentation and reinforcement of inaccurate science concepts through this genre has serious implications from the science educator's perspective. This problem is further complicated by the fact that the age at which young children begin to separate fact from fiction or from fantasy varies (Stoodt, Amspaugh and Hunt, 1996).

At present, teachers are being encouraged to teach science using trade books despite the dearth of knowledge about the influence which this type of literature has on learning in science. While the results of this study indicate that science trade books are the best source of accurate information out of the several types of books examined, caution in using any type of children's trade books in teaching science is advised. Having identified a fairly large number of science concepts and themes found in a variety of types of children's trade books, the next step is to determine what elementary

children actually learn from science instruction using these books and how this knowledge influences subsequent learning.

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Stiffler, L. (1992, March). Solution in the shelves. *Science and Children*, 17, 46.

Stoodt, BI, Amspaugh, L., Hunt, J. (1996). *Children's Literature, Discovery for a Lifetime.* Scottsdale, AZ: Gorsuch Scarisbrick, Publishers.

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Appendix A

Brown, M. (1947). *Goodnight, Moon.* Harper Trophy.
Bruchac, J. (1992).*Thirteen Moons on a Turtle's Back.* New York: Philomel Books.
Burton, V. (1942). *The Little House.* Boston: Houghton Mifflin Company.
Carle, E. (1986). *Papa, Please Get the Moon for Me.* Maine: Picture Book Studio.
Dragonwagon, C. (1986) *Half a Moon and One Whole Star.* New York: Aladdin Books
Frasier, D. (1991). *On the Day You Were Born.* San Diego: Harcourt Brace.
Preston, E. (1974). *Squawk to the Moon, Little Goose* . New York: Puffin Books.
Thurber, J. (1943). *Many Moons.* New York: Harcourt Brace Jovanovich.
Weeks, S. (1995). *Follow the Moon.* New York: Harper Collins.
Yolen, J. (1987). *Owl Moon.* New York: Philomel Books..

Appendix B

Sample of Fifty Books Analyzed

Author: Eric Carle

(1987). *A House for Hermit Crab.* Maine: Picture Book Studio.
(1986). *Papa, Please Get the Moon for Me* . Maine: Picture Book Studio.
(1972). *Rooster's Off to See the World.* New York: Scholastic Inc.
(1977). *The Grouchy Lady Bug.* Hong Kong: Harper Collins Publishers.
(1975). *The Mixed-Up Chameleon.* New York: Scholastic Inc.
(1987). *The Tiny Seed.* New York: Scholastic Inc.
(1984). *The Very Busy Spider* . New York: Philomel Books.
(1969). *The Very Hungry Caterpillar* . New York: Scholastic Inc.

Author: Helen Cowcher

(1990). *Antarctica.* New York: Scholastic Inc.
(1988). *Rain Forest* . USA: Sunburst Books.

Author: Tomie dePaola

(1975). *The Cloud Book.* New York: Holiday House.
(1978). *The Popcorn Book* . New York: Holiday House.
(1977). *The Quicksand Book.* New York: Holiday House.

Author: Ruth Heller

(1981). *Chickens Aren't The Only Ones* . New York: Grosset & Dunlap.
(1992). *How To Hide a Butterfly.* Canada: Grosset & Dunlap.
(1994). *How to Hide a Polar Bear* . New York: Grosset & Dunlap.
(1983). *The Reason for a Flower* . New York: Scholastic Inc.

Author: Leo Lionni

(1983). *The Biggest House in the World Cornelius.* New York: Dragonfly Books.
(1983). *Cornelius.* New York: Dragonfly Books.
(1995). *An Extraordinary Egg.* New York: Scholastic Inc.
(1970). *Fish is Fish* . New York: Dragonfly Books.
(1963). *Swimmy.* New York: Dragonfly Books.

Author: Jerry Pallotta

(1986). *The Bird Alphabet Book.* Maine: Charlesbridge Publishing.
(1993). *The Extinct Alphabet Book.* Maine: Charlesbridge Publishing.
(1988). *The Flower Alphabet Book.* Maine: Charlesbridge Publishing.
(1990). *The Frog Alphabet Book.* Maine: Charlesbridge Publishing.
(1986). *The Icky Bug Alphabet Book.* Maine: Charlesbridge Publishing.
(1986). *The Ocean Alphabet Book.* Maine: Charlesbridge Publishing.
(1996). *The Victory Garden Alphabet Book.* Maine: Charlesbridge Publishing.
(1989). *The Yucky Reptile Alphabet Book.* Maine: Charlesbridge Publishing.

Various Authors:

Baker, J. (1987). *Where the Forest Meets the Sea.* New York: Scholastic Inc.
Baker, J. (1990). *Who Is The Beast?* San Diego: Harcourt Brace & Company.
Cho, S. (1994). *The Gas We Pass.* New York: Kane/Miller.
Dorros, A. (1990). *Rain For[illegible] Secrets.* New York: Scholastic Inc.
Ehlert, L. (1995). *Snowballs.* San Diego: Harcourt Brace & Company.
Fleming, D. (1993). *In the Small, Small Pond.* New York: Scholastic Inc.
Fleming, D. (1991). *In the Tall, Tall Grass.* New York: Scholastic.
Frasier, D. (1991). *On the Day You Were Born.* San Diego: Harcourt Brace.
Howe, J. (1987). *I Wish I Were a Butterfly.* San Diego: Harcourt Brace & Company.
Luenn, N. (1992). *Mother Earth.* New York: Aladdin Paperbacks.
Nayer, J. (1994). *A Tree Can Be.* New York: Scholastic Inc.
Parker, N. (1987). *Bugs.* New York: Mulberry Books.
Peters, L. (1988). *The Sun, the Wind and the Rain* . New York: Scholastic Inc.
Pratt, K. (1992). *A Walk in the Rainforest.* California: Dawn Publications.
Romanova, N. (1985). *Once There Was a Tree.* New York: Dial Books.
Schoenherr, J. (1995). *Rebel.* New York: Philomel Books.
Singer, M. (1995). *A Wasp is Not a Bee.* New York: Henry Holt and Company.
Weeks, S. (1995). *Follow the Moon.* New York: Harper Collins.
Wells, R. (1993). *Is a Blue Whale the Biggest Thing There Is?* Illinois: Albert Whitman & Company.
Young, E. (1995). *Night Visitors.* New York: Philomel Books.